EMC Standards and Regulations

by Robin Hewes, I Eng FIEIE, G3TDR, and Alan Dearlove, G1WZZ

THE OVERVIEW

EMC (Electromagnetic Compatibility) is generally divided into two interlinked areas, namely EMI (Electromagnetic Interference) and EMS (Electromagnetic Susceptibility). EMI is defined as the degree or level of interference, from an electrical or electronic device, constructed in such a way that an adequate level of electromagnetic immunity exists in the usual electromagnetic compatibility environment, according to approved European or National Standards. Conversely, EMS is defined as the ability of an electrical or electromagnetic device to be immune to any interfering signal that is applied to it, which can influence its performance or function, according to National Standards.

Electromagnetic Interference

At present, civil EMI regulations are governed at an international level by the IEC (International Electrotechnical Commission). Within the IEC, a sub-committee known as CISPR (Committee International Special des Perturbations Radioelectriques), governs EMC matters. CISPR issues directives to an association formed by seventeen National Electrotechnical Committees, in Europe known as CENELEC (members of the European Community plus Austria, Finland, Norway, Spain, Sweden and Switzerland). The prime purpose of CENELEC is to harmonise technical matters between Committee members, and so achieve compatibility between national standards.

At a national level, regulations are controlled in Germany by the VDE (German Bundespost), in the USA, by the FCC (Federal Communications Commission), in the UK by BSI (British Standards Institute) and in Canada by the DOC (Department of Communications).

National regulations are based on recommendations published by CISPR, and as a result they are essentially similar in fundamental issues. CISPR publications determine in particular:-

(a) Field of application according to equipment type.
(b) Measurement procedures.
(c) Maximum limits.

The pertinent CISPR publications are as follows:-

(1) Publication 11 of 1975, gives the limits and methods of measurement of radio frequency characteristics of industrial, scientific and medical (ISM) radio frequency equipment, excluding surgical diathermy apparatus.
(2) Publication 12 of 1978: The limits and methods of measurement of vehicles, motor boats and spark ignited engine driven devices.
(3) Publication 13 of 1975: The limits and methods of measurement of radio interference characteristics of sound and television receivers.
(4) Publication 14 of 1985: The limits and methods of measurement of radio interference characteristics of household electrical appliances, portable tools and similar electrical apparatus.
(5) Publication 16 of 1977 contains amendments No 1 (1980) and No 2 (1983) giving the specification of radio interference measuring apparatus and methods of measurement.

Although these recommendations are included in international regulations they are not mandatory. By contrast, EC and national regulations are mandatory and equipment not designed in accordance with them must not be permitted to be operated.

A summary of the important national regulations is given in Table 1.

CISPR	CONTENTS	UK BSI	USA FCC	GERMANY VDE	EG EEC
11	Industrial scientific and medical equipment Narrowband (F>10kHz)	4890	Part 18	0871	—
12	Vehicles (Narrow and broadband interference)	833	—	0879	72/245/EEC
13	Radio and television receivers	905	Part 15	0872	75/322/EEC
14	Electrical equipment (broadband interference), household appliances, portable tools	800	Part 15	0875 Part 1 and 3	82/499/EEC
15	Electric lamps (all types)	5384		0875 Part 2	82/500/EEC
16	EMI measuring devices and procedures	727		0876 0877	
22	Computing devices	6527	Part 15J	0871A1	
—	Telecommunication			0878	
—	Energy supply/ electric trains			0873	

TABLE 1

This regulation requires test procedures for the measurement of the physical units given in Table 2.

	EMI Voltage (conducted)	Magnetic Field strength	Electrical Field strength	EMI Power
Frequency range	10kHz-30MHz (Broadband 150kHz-30MHz)	10kHz-30MHz B/band to 1GHz	30MHz-18GHz	30MHz-300MHz
Measurements with test receiver	Artificial mains network probe	Loop antenna	Rod antenna dipole	Power absorbing clamp
Test site	Shielded room (recommended) shielded room	Non-conductive field site,	Conductive open field site	Shielded room recommended
Remarks	On all phases	Main radiation direction of "device under test" - limits given as electrical field strength	Measurement with variation of antenna height; angle and polarisation	

TABLE 2

These test procedures are beyond the scope of the majority of radio amateurs, and the cost of equipment and the test sites would be prohibitive. Radio equipment manufacturers, however, should have the necessary facilities and test equipment.

While not strictly relevant, it is of interest to note that military equipment is governed by its own regulations - for instance, in NATO, MIL standards are issued by the American Department of Defence. All regulations are tailored for interference free operation under battle conditions.

Electromagnetic Susceptibility

EMS is better known to radio amateurs as RFI, that is HF or VHF interference to radio or TV reception. It occurs when an undesired signal and a wanted signal are received together. Interfering signals can enter receivers by three different routes:-

- Through the antenna terminal.
- Through the mains, loudspeaker, headphones and AF inputs/outputs.
- By radiation directly into the receiver itself.

Interfering signals can also enter other types of electrical and electronic apparatus such as audio equipment, telephones, alarm systems, and the proliferation of all types of transmitters, including broadcast, private mobile radio. Amateur and CB have increased the significance of EMS in recent years. To help alleviate the problem, it has been necessary to set standards and specifications to ensure that equipment subject to RF fields has adequate immunity.

EMS standards have been issued by CISPR in the publications described below:-

CISPR/IEC Publication 16 (1987).

CISPR specification for radio interference measuring apparatus and measuring methods.

CISPR/IEC Publication 20 (1985).

Measurement of the immunity of sound and television receivers and associated equipment in the frequency range 1.5 to 30MHz, by the current injection method. Guidance on immunity requirements for reduction of interference caused by radio transmitters in the frequency range 1.5 to 30MHz.

CISPR/IEC/SC-E (Secretariat) 35.

Limits and methods of measurement of immunity characteristics of broadcast receivers and associated equipment.

IEC Publication 315.

Methods of measurement on radio receivers for various classes of emission. Part 1: General conditions, measurements and measuring methods applying to most types of receivers (not TRF).

As with EMI, the test facilities and equipment necessary to conduct measurements for EMS limits is beyond the scope of most radio amateurs, again only equipment manufacturers would be able to conduct tests for limits of susceptibility to other radiating sources.

Progress Toward Harmonisation

Over a period of many years, the governments of many countries in Europe have introduced their own EMC regulations, so there are now different regulations from country to country. This far from perfect situation has led to the commitment of these countries to harmonise the technical requirements in a Directive of European Standards to be introduced to the 1992 Single European Market.

Technical harmonisation was started by CENELEC

in 1984 by the publishing of Harmonised Documents based on CISPR Publications with the intention that these papers should replace the different national standards. Unfortunately, this did not prove possible, as each country raised objections and CENELEC then concentrated on issuing its papers as ENs (European Standards). The members of CENELEC are not allowed to revise and re-issue their own national standards, and they are obliged to accept the European Standard as a national standard 18 months after the date of issue.

The current CISPR international standards now reflect the requirements of the Commercial EMC Regulations of the Single European Market as shown in Table 3.

Type of equipment	International standard	European RFI standard
Industrial scientific and medical	CISPR 11	pr EN 55011
Information technology	CISPR 22	EN 55022
TV and broadcast receivers RFI emission	CISPR 13 and CISPR 20	pr EN 55013 EN 55020
Household appliances	CISPR 14	EN 55014
Lighting and fluorescent lamps	CISPR 15	EN 55015

TABLE 3

N.B. pr indicates standards under preparation.

European Standards are the only technical basis for free movement of goods within the Single European Market. A Council of European Communities controls these standards as part of the Council Directives which are now national laws. The first Council Directive - relating to the suppression of RFI due to spark ignition on petrol engines fitted to motor vehicles - was issued in 1972.

The directive on EMC, requires that all RFI standardizing problems will be covered by the EMC Directive No 89/336/EEC. This directive contains 13 articles, in which "protection requirements" only are defined. It states that all electrical and electronic equipment shall be constructed such that (a), the electromagnetic disturbance it generates shall not exceed a level which would prevent radio and telecommunication equipment from operating normally, and (b), the equipment shall have an adequate level of intrinsic immunity to electromagnetic disturbance for it to operate normally. Annex III of the directive details the equipment to be considered for protection under the EMC national standards. This equipment must obviously be constructed in such a way that it has an adequate level of EMI and EMS to meet these standards.

Equipment types under consideration:-

(1) Domestic radio and television receivers.
(2) Mobile radio; land and private.
(3) Mobile radio and commercial radio telephone.
(4) Information technology (computers and peripherals).
(5) Domestic appliances and household electronic.
(6) Educational electronic.
(7) Medical and scientific.
(8) Industrial and manufacturing.
(9) Aeronautical and marine radio.
(10) Telecommunication networks and apparatus.
(11) Radio and television broadcast transmitters.
(12) Lights and fluorescent lamps.

So, how do the present and forthcoming regulations affect the radio amateur? As we all know only too well, the tracing and curing of RFI breakthrough problems in our neighbour's radio and TV equipment is very much a "do it yourself" activity - possibly with some help from the Radiocommunications Agency (DTI). However, the amateur stands little or no chance of eliminating received interference from line time bases or switch mode power supplies. The new regulations coming into force in 1992 will mean that any device that generates RFI - including TV and computer equipment - will have to be designed and manufactured to meet the new EMC directives, and hence limits on radiated EMI (RFI). Even the ordinary electric lamp bulb or its more sinister big brother, the fluorescent lamp – both well known sources of interference – will have to meet the new limits of EMI radiation by the end of 1992. By this date all manufacturers both inside and outside Europe placing an electronic or electrical device on the European market, must give an EC Declaration of Conformity on the device. This declaration is held at the disposal of the competent authority for the period of ten years. The manufacturer has to affix an "EC Conformity Mark" to the device to indicate that it meets all the EMC requirements. The new directives should be beneficial to all radio amateurs in years to come.

THE EUROPEAN COMMUNITY EMC DIRECTIVE AND ITS IMPLICATIONS FOR AMATEUR RADIO

General

As indicated above, this Directive is an integral part of establishing a single European market and is intended to provide an electromagnetic environment for the reliable operation of all electrical and electronic equipment. The objectives defined by the Directive will be mandatory. However, standards are only defined as a means of demonstrating that the objectives have been achieved and are not themselves binding. These standards are therefore adaptable to technological progress ensuring that development of new products may continue.

From 1 January 1992, all electrical and electronic equipment "placed on the market and taken into service" must comply with the objectives of the European Community EMC Directive. This will apply to new and existing designs.

Scope of the Directive

All electrical and electronic equipment is within the scope of the Directive, and the existing Directives covering domestic equipment and luminaires will be absorbed into it. (There is one exception relating to amateur radio equipment which will be discussed later). The definitions of electromagnetic disturbances, as described in the Directive, are all embracing. Standard tests for conducted and radiated emissions are well known, but immunity to electromagnetic field, mains disturbances, electrostatic discharge and lightning induced surges now have to be considered in the compliance of a product.

The Directive sets out two essential requirements:-

(1) Equipment shall not generate electromagnetic disturbances exceeding a level allowing radio and telecommunications and other apparatus to operate as intended.
(2) Equipment shall have an adequate level of intrinsic immunity from electromagnetic disturbances.

This means that your equipment must not make too much radio or electrical noise when it is working, and must also continue to operate satisfactorily when subjected to reasonably high levels of radio fields, or by electrical disturbances on either its electrical power supply or other cables.

Proof of Compliance

The following is an extract from the DTI's leaflet on EMC.

'Most manufacturers will not be able to make the necessary assessment of whether their equipment satisfies the two essential requirements and so the Directive invokes the use of (harmonised) European EMC Standards. Any equipment which complies with these relevant standards will be deemed to meet the essential requirements.

As an alternative, you as a manufacturer, are free to determine your own method of technical assessment (indeed you may have to if there is not yet a relevant EMC standard). When you make your own assessment, you are required to keep a technical file containing the details of the method used, the test results and a supporting statement by an independent, competent body. You must keep the file at the disposal of the national administration. Manufacturers of certain telecommunications terminal equipment and radio transmitters (excluding apparatus for radio amateurs) are not able to self-certify. If you market such apparatus, you will need to obtain an EC-type examination certificate from an accredited test house before certifying that your product complies with the Directive.'

Amateur Radio Equipment

The DTI recently issued a document, "Electrical Interference: A Consultative Document." The purpose of the document is to describe, and to seek views on, the DTI's proposals to implement the Directive. The RSGB has formed a small working group to coordinate the responses to the document.

As mentioned previously, certain amateur radio equipment is excluded from the requirement to meet the objectives of the Directive. The requirement for compliance does not extend to "amateur radio equipment which is not commercially available." This can have a range of interpretations.

It is obvious that true "home brewed equipment" does not have to comply, but the problem of home brew from kits of parts bought from a commercial source is an area of major concern for the RSGB. Early indications from the Consultative document states, "It is proposed that products sold commercially in kit form should have to comply when constructed in accordance with the instructions." The RSGB opposes this line.

Second-hand equipment is another concern. If sold between two radio amateurs the equipment does not have to comply (not sold commercially), but if bought from your local emporium the equipment will probably have to comply.

The RSGB has been and is spending considerable time and effort in attempting to resolve the many questions that arise from the EC EMC Directive. It is difficult for those involved to make categoric statements as circumstances are changing continually. Much work has been done on this subject by the IARU Region I EC Committee. This Committee consists of representatives from the European Community Amateur Radio Societies. Discussions are being held with members of the Commission in Brussels, but the final interpretations of the meanings and implementations can only be decided by the European Courts of Justice to whom submissions must be made if disagreement exists. ❑